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Silver Lake
Mono County, California

(U.S.) National Eutrophication Survey, Corvallis, OR

Prepared for

Corvallis Environmental Research Lab, OR

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

REPORT
ON
SILVER LAKE
MONO COUNTY
CALIFORNIA
EPA REGION IX
WORKING PAPER No. 759

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON
and
ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

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REPORT
ON
SILVER LAKE
MONO COUNTY
CALIFORNIA
EPA REGION IX
WORKING PAPER No. 759

WITH THE COOPERATION OF THE
CALIFORNIA STATE WATER RESOURCES CONTROL BOARD
AND THE
CALIFORNIA NATIONAL GUARD
JUNE, 1978

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		48G

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentration (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGEMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the California State Water Resources Control Board and the nine Regional Water Quality Control Boards for professional involvement, to the California National Guard for conducting the tributary sampling phase of the Survey, and to those California wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the Division of Planning and Research of the State Water Resources Control Board provided invaluable lake documentation and counsel during the Survey, coordinated the reviews of the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

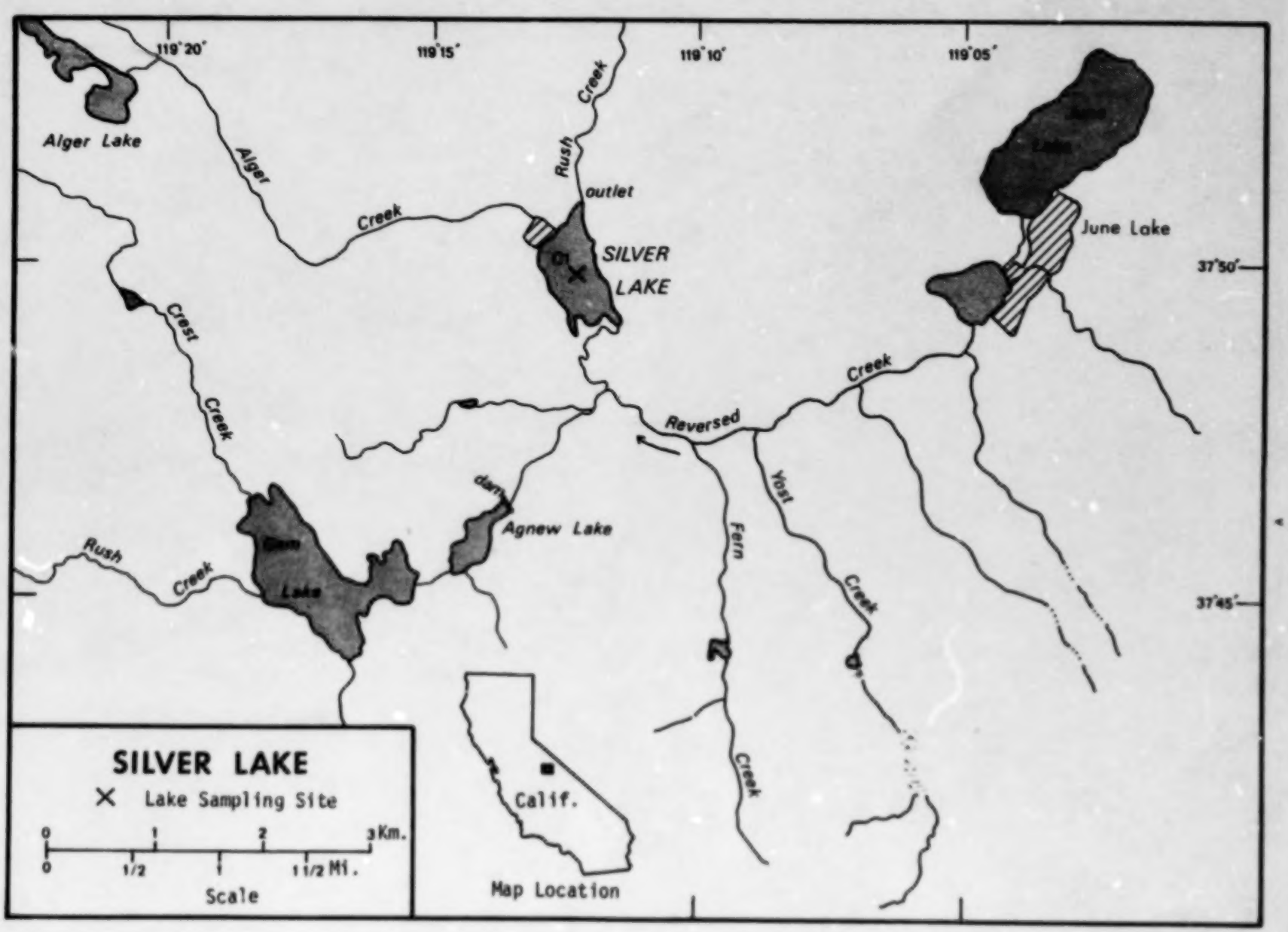
Major General Glen C. Ames, the Adjutant General of California, and Project Officer Second Lieutenant Terry L. Barrie, who directed the volunteer efforts of the California National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY RESERVOIRS

State of California

Name	County
Amador	Amador
Boca	Nevada
Britton	Shasta
Casitas	Ventura
Crowley	Mono
Don Pedro	Tuolumne
Elsinore	Riverside
Fallen Leaf	El Dorado
Hennessey	Napa
Henshaw	San Diego
Iron Gate	Siskiyou
Lopez	San Luis Obispo
Mary	Mono
Mendocino	Mendocino
Nicasio	Marin
Lower Otay	San Diego
Pillsbury	Lake
Santa Margarita	San Luis Obispo
Shasta	Shasta
Shaver	Fresno
Silver	Mono
Tahoe	El Dorado, Placer, CA; Carson City, Douglas, Washoe, NV
Tulloch	Calaveras, Tuolumne
Lower Twin	Mono
Upper Twin	Mono


119°20'
119°15'
119°10'
119°05'
37°50'
37°45'
Alger Lake
Alger Creek
Rush Creek
outlet
SILVER LAKE
June Lake
Crest Creek
Reversed Creek
dam
Agnew Lake
Rush Creek
Lake
Fern Creek
Yost Creek
SILVER LAKE
Lake Sampling Site
0 1 2 3 Km.
0 1/2 1 1 1/2 Mi.
Scale
Calif.
Map Location

SILVER LAKE

STORET NO. 0623

I. INTRODUCTION

Silver Lake was included in the National Eutrophication Survey as a water body of interest to the California State Water Resources Control Board. Tributaries and nutrient sources were not sampled, and this report relates only to the lake sampling data.

II. CONCLUSIONS

A. Trophic Condition*:

Survey data indicate that Silver Lake is oligotrophic. It ranked third in overall trophic quality among the 24 California lakes and reservoirs sampled in 1975 when compared using a combination of six water quality parameters**. Two of the water bodies had less and one had the same median total phosphorus, one had less and two had the same median dissolved orthophosphorus, eight had less median inorganic nitrogen, three had less mean chlorophyll a, and five had greater mean Secchi disc transparency. No depression of dissolved oxygen with depth occurred at any of the three sampling times.

B. Rate-Limiting Nutrient:

The algal assay results are not considered representative of conditions in the lake at the times samples were collected. The lake data indicate nitrogen limitation in early June but phosphorus limitation at the other two sampling times.

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* Trophic assessment is based on levels of nutrients, dissolved oxygen, and chlorophyll a; photoplankton kinds and numbers; and transparency (Allum et al., 1977).

** See Appendix A.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Morphometry††:

1. Surface area: 0.45 kilometers^2.
2. Mean depth: 10.5 meters.
3. Maximum depth: Unknown.
4. Volume: 4.737×10^6 m^3.

B. Precipitation*:

1. Year of sampling: 8.1 centimeters.
2. Mean annual: 14.5 centimeters.

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† Table of metric equivalents--Appendix B.
†† Dendy, 1974.
* See Working Paper No. 175, "... Survey Methods, 1973-1976".

IV. WATER QUALITY SUMMARY

Silver Lake was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from a number of depths at one station on the lake (see map, page v). During each visit, a single depth-integrated (4.6 m to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was taken for chlorophyll a analysis. During the first and last visits, a single 18.9-liter depth-integrated sample was collected for algal assays. The maximum depth sampled was 14.6 meters.

The sampling results are presented in full in Appendix C and are summarized in the following table.

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR SILVER LAKE
STORET CODE 0623

PARAMETER	1ST SAMPLING (6/10/75) 1 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (6/30/75) 1 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (11/ 5/75) 1 SITES RANGE	MEAN	MEDIAN
TEMP (C)	4.9 - 7.4	5.9	5.8	5.6 - 8.0	7.3	7.5	6.1 - 6.2	6.1	6.1
DISS OXY (MG/L)	8.6 - 9.6	9.1	9.4	8.4 - 8.6	8.5	8.6	8.6 - 9.2	8.8	8.8
CNDCTVY (MCROMO)	32. - 33.	32.	32.	25. - 41.	31.	30.	61. - 63.	62.	62.
PH (STAND UNITS)	7.5 - 7.7	7.6	7.6	7.5 - 7.7	7.6	7.5	7.5 - 7.5	7.5	7.5
TOT ALK (MG/L)	18. - 23.	20.	20.	23. - 26.	25.	26.	22. - 23.	23.	23.
TOT P (MG/L)	0.012 - 0.013	0.012	0.012	0.010 - 0.013	0.011	0.010	0.010 - 0.014	0.011	0.010
ORTHO P (MG/L)	0.009 - 0.015	0.013	0.014	0.002 - 0.004	0.003	0.003	0.002 - 0.002	0.002	0.002
NO2+NO3 (MG/L)	0.030 - 0.040	0.034	0.030	0.020 - 0.050	0.028	0.020	0.020 - 0.020	0.020	0.020
AMMONIA (MG/L)	0.030 - 0.040	0.032	0.030	0.020 - 0.040	0.026	0.020	0.020 - 0.020	0.020	0.020
KJEL N (MG/L)	0.200 - 0.200	0.200	0.200	0.200 - 0.200	0.200	0.200	0.200 - 0.200	0.200	0.200
INORG N (MG/L)	0.060 - 0.080	0.066	0.060	0.040 - 0.070	0.054	0.050	0.040 - 0.040	0.040	0.040
TOTAL N (MG/L)	0.230 - 0.240	0.234	0.230	0.220 - 0.250	0.228	0.220	0.220 - 0.220	0.220	0.220
CHLRPYL A (UG/L)	1.5 - 1.5	1.5	1.5	2.2 - 2.2	2.2	2.2	1.7 - 1.7	1.7	1.7
SECCHI (METERS)	3.2 - 3.2	3.2	3.2	4.1 - 4.1	4.1	4.1	****** - **********		

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
06/10/75	1. Chroomonas (?) sp.	343
	2. Dinobryon sp.	115
	3. Asterionella sp.	38
	4. Cryptomonas sp.	38
	5. Synedra sp.	38
	Total	572
06/30/75	1. Chroomonas (?) sp.	228
	2. Dinobryon sp.	114
	3. Synedra sp.	114
	4. Asterionella sp.	76
	Total	532
11/05/75	1. Chroomonas (?) sp.	57
	2. Cryptomonas sp.	45
	3. Dinobryon sp.	11
	Total	113

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
06/10/75	1	1.5
06/30/75	1	2.2
11/05/75	1	1.7

C. Limiting Nutrient Study:

The algal assay results are not considered representative of conditions in the lake due to significant changes in nutrients in the samples during shipment from the field to the laboratory. However, the lake data indicate nitrogen limitation in early June and phosphorus limitation in late June and in November. The mean inorganic nitrogen/orthophosphorus ratios were 5/1 in early June and 18/1 or greater at the other sampling times.

V. LITERATURE REVIEWED

Allum, M.O., R.E. Glessner, and J.H. Gakstatter, 1977. An evaluation of the National Eutrophication Survey data. Working Paper No. 900, Corvallis Env. Res. Lab. Corvallis, OR.

Dendy, William B., 1974. Personal communication. (waterbody information and morphometry). CA Water Res. Contr. Bd., Sacramento.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	SSO-MEAN SEC	MEAN CHLOPA	15-MIN DO	MEDIAN DISS ORTHO P
0601	AMADOR RESERVOIR	0.040	0.390	408.667	22.383	14.600	0.020
0602	BOCA LAKE	0.012	0.040	372.833	1.700	6.800	0.003
0603	LAKE BRITTON	0.067	0.115	446.500	4.811	11.200	0.047
0604	CASITAS RESERVOIR	0.029	0.050	400.250	3.192	14.000	0.014
0605	CROWLEY LAKE	0.046	0.045	374.750	5.800	12.200	0.034
0606	DON PEDRO RESERVOIR	0.013	0.060	381.733	3.564	11.400	0.004
0607	LAKE ELSINORE	0.469	0.120	489.214	70.572	8.000	0.092
0608	FALLEN LEAF RESERVOIR	0.007	0.040	24.357	0.786	8.800	0.005
0609	LAKE HENNESSEY	0.027	0.060	416.000	4.525	15.000	0.012
0610	LAKE HENSHAW	0.138	0.070	461.000	26.783	9.800	0.073
0611	IRON GATE RESERVOIR	0.184	0.690	440.333	6.217	13.800	0.124
0614	LOPEZ LAKE	0.371	0.090	372.000	8.658	15.000	0.343
0615	LAKE MARY	0.010	0.040	296.000	2.550	10.600	0.002
0616	LAKE MENDOCINO	0.020	0.050	436.500	3.100	9.400	0.008
0617	NICASIO RESERVOIR	0.055	0.345	482.778	6.633	9.800	0.013
0618	LOWER OTAY RESERVOIR	0.058	0.180	447.250	15.933	15.000	0.013
0619	LAKE PILLSBURY	0.022	0.060	466.667	6.389	8.200	0.008
0620	SANTA MARGARITA LAKE	0.037	0.070	400.000	9.122	14.800	0.014
0621	SHASTA LAKE	0.021	0.060	381.542	4.087	9.000	0.015
0622	SHAVER	0.014	0.060	346.400	1.700	7.400	0.004
0623	SILVER LAKE	0.012	0.055	356.000	1.800	7.000	0.003
0624	TULLOCK RESERVOIR	0.025	0.060	433.000	13.878	7.400	0.009
0625	UPPER TWIN LAKES	0.015	0.040	300.200	3.340	7.400	0.004
0626	LOWER TWIN LAKES	0.014	0.040	248.000	2.900	11.400	0.003

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NU
0601	AMADOR RESERVOIR	35 (8)	4 (1)	43 (10)	9 (2)	17 (4)	26 (6)	134
0602	BOCA LAKE	89 (20)	98 (22)	70 (16)	91 (21)	100 (23)	91 (20)	539
0603	LAKE BRITTON	17 (4)	22 (5)	17 (4)	48 (11)	43 (10)	17 (4)	164
0604	CASITAS RESERVOIR	43 (10)	74 (17)	48 (11)	70 (16)	22 (5)	37 (8)	294
0605	CROWLEY LAKE	30 (7)	78 (18)	65 (15)	43 (10)	30 (7)	22 (5)	268
0606	DON PEDRO RESERVOIR	83 (19)	54 (11)	57 (13)	61 (14)	37 (8)	78 (17)	370
0607	LAKE ELSINORE	0 (0)	17 (4)	0 (0)	0 (0)	78 (18)	9 (2)	104
0608	FALLEN LEAF RESERVOIR	100 (23)	87 (19)	100 (23)	100 (23)	70 (16)	70 (16)	527
0609	LAKE HENNESSEY	48 (11)	54 (11)	39 (9)	52 (12)	4 (0)	52 (12)	249
0610	LAKE HENSHAW	13 (3)	33 (7)	13 (3)	4 (1)	54 (12)	13 (3)	130
0611	IRON GATE RESERVOIR	9 (2)	0 (0)	26 (6)	39 (9)	26 (6)	4 (1)	104
0614	LOPEZ LAKE	4 (1)	26 (6)	74 (17)	26 (6)	4 (0)	0 (0)	134
0615	LAKE MARY	96 (22)	87 (19)	91 (21)	83 (19)	48 (11)	100 (23)	505
0616	LAKE MENDOCINO	65 (15)	70 (16)	30 (7)	74 (17)	61 (14)	63 (14)	363
0617	NICASIO RESERVOIR	26 (6)	9 (2)	4 (1)	30 (7)	54 (12)	46 (10)	169
0618	LOWER OTAY RESERVOIR	22 (5)	13 (3)	22 (5)	13 (3)	4 (0)	46 (10)	120
0619	LAKE PILLSBURY	57 (13)	41 (9)	9 (2)	35 (8)	74 (17)	63 (14)	279
0620	SANTA MARGARITA LAKE	39 (9)	33 (7)	52 (12)	22 (5)	13 (3)	37 (8)	196
0621	SHASTA LAKE	61 (14)	54 (11)	61 (14)	57 (13)	65 (15)	30 (7)	328
0622	SHAVER	78 (18)	41 (9)	83 (19)	96 (22)	87 (19)	78 (17)	463
0623	SILVER LAKE	89 (20)	65 (15)	78 (18)	87 (20)	96 (22)	91 (20)	506
0624	TULLOCK RESERVOIR	52 (12)	54 (11)	35 (8)	17 (4)	87 (19)	57 (13)	302
0625	UPPER TWIN LAKES	70 (16)	98 (22)	87 (20)	65 (15)	87 (19)	78 (17)	485
0626	LOWER TWIN LAKES	74 (17)	87 (19)	96 (22)	78 (18)	37 (8)	91 (20)	463

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	0602	BOCA LAKE	539
2	0608	FALLEN LEAF RESERVOIR	527
3	0623	SILVER LAKE	506
4	0615	LAKE MARY	505
5	0625	UPPER TWIN LAKES	485
6	0626	LOWER TWIN LAKES	463
7	0622	SHAVER	463
8	0606	DON PEDRO RESERVOIR	370
9	0616	LAKE MENDOCINO	363
10	0621	SHASTA LAKE	328
11	0624	TULLOCK RESERVOIR	302
12	0604	CASITAS RESERVOIR	294
13	0619	LAKE PILLSBURY	279
14	0605	CROWLEY LAKE	268
15	0609	LAKE HENNESSEY	249
16	0620	SANTA MARGARITA LAKE	196
17	0617	NICASIO RESERVOIR	169
18	0603	LAKE BRITTON	164
19	0614	LOPEZ LAKE	134
20	0601	AMADOR RESERVOIR	134
21	0610	LAKE HENSHAW	130
22	0618	LOWER OTAY RESERVOIR	120
23	0607	LAKE ELSINORE	104
24	0611	IRON GATE RESERVOIR	104

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 - cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 76/09/24

062301
37 46 44.0 119 07 33.0 3
SILVER LAKE
06051 CALIFORNIA

11EPALES 751126 2111202
0045 FEET DEPTH CLASS 00

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
75/06/10	09 00	0000	7.4	8.0	126	32	7.70	20	0.030	0.200K	0.030	0.015
	09 00	0005	5.9	9.4		33	7.60	18	0.030	0.200K	0.030	0.014
	09 00	0020	5.8	9.6		32	7.50	20	0.030	0.200K	0.030	0.014
	09 00	0031	5.5	9.6		32	7.60	19	0.040	0.200K	0.040	0.009
	09 00	0041	4.9	8.8		33	7.70	23	0.030	0.200K	0.040	0.014
75/06/30	11 00	0000	8.0	8.6	162	25	7.50	26	0.020	0.200K	0.050	0.004
	11 00	0005	7.9	8.6		29	7.50	26	0.020	0.200K	0.020K	0.003
	11 00	0015	7.5	8.6		30	7.70	26	0.020	0.200K	0.020K	0.003
	11 00	0025	7.3	8.4		31	7.60	26	0.040	0.200	0.030	0.002
	11 00	0045	5.6	8.4		41	7.50	23	0.030	0.200	0.020	0.002K
75/11/05	14 15	0000	6.2	8.6		63	7.50	23	0.020K	0.200K	0.020K	0.002
	14 15	0005	6.1	8.8		62	7.50	23	0.020K	0.200K	0.020K	0.002
	14 15	0024	6.1	9.2		61	7.50	22	0.020K	0.200K	0.020K	0.002K
	14 15	0048	6.1	8.8		61	7.50	23	0.020K	0.200K	0.020K	0.002

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
75/06/10	09 00	0000	0.013	1.5	
	09 00	0005	0.012		
	09 00	0020	0.012		
	09 00	0031	0.012		
	09 00	0041	0.012		
75/06/30	11 00	0000	0.010	2.2	
	11 00	0005	0.010		
	11 00	0015	0.010		
	11 00	0025	0.013		
	11 00	0045	0.012		
75/11/05	14 15	0000	0.014	1.7	
	14 15	0005	0.010		
	14 15	0024	0.011		
	14 15	0048	0.010		

K VALUE KNOWN TO BE
LESS THAN INDICATED